THE EFFECT OF LOW INFLATION ON PUBLIC FINANCES

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The paper analyses the impact of an unanticipated disinflation shock and finds evidence of an adverse impact on fiscal balances given rigidities in nominal government spending, which limit the downward adjustment to lower inflation, whereas revenues tend to decline much faster. Moreover, the impact on the debt-to-GDP ratio tends to be stronger and more persistent given the adverse implications of the denominator effect. Country specific features are found to play an important role, whereas second round, though important, effects coming from the impact of low inflation on real GDP growth are not fully taken into account given the lack of available evidence for euro-area countries.

Given the gradual decline in inflation rates in the euro area and the weak growth performance in several member countries, this paper aims to analyse the direct transmission mechanisms of inflation developments on public finances by taking into account country-specific features.

The paper provides evidence that an unanticipated disinflation shock has an adverse impact on fiscal balances given rigidities in nominal government spending, which limit the downward adjustment to lower inflation, whereas revenues tend to decline much faster. Moreover, the impact on the debt-to-GDP ratio tends to be stronger and more persistent given the adverse implications of the denominator effect. Country specific features are found to play an important role, whereas second round, though important, effects coming from the impact of low inflation on real GDP growth are not fully taken into account given the lack of available evidence for euro-area countries.

This is one of the few papers providing a comprehensive analysis of the fiscal effects of low inflation. It focuses on the case of Germany, France, Italy, Austria and Greece and looks into the transmission channels of low inflation on the main fiscal aggregates in two steps.

First, by using the fiscal forecast model of each National Central Bank, the paper presents model based simulations where country-specific features regarding the dynamics of expenditures and receipts are documented in detail and taken into account for a deeper understanding of how price shock translates to government balances in the simulations displayed. In particular, the paper finds that in response to an unexpected (temporary) disinflation shock of –1p.p. the primary balance deteriorates on average by 0.15p.p. of GDP in the first year. This is attributed to the

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finding that total nominal revenues decline more than nominal primary expenditures which, at least initially, display some rigidity. The size and duration of the deterioration in the primary balance tends to be country specific. Moreover, if lower inflation feeds through to lower market interest rates (i.e., via lower inflation expectations), the impact on the headline budget balance would be cushioned by the reduction in interest payments on newly issued debt. The effects tend to be stronger in case the growth rate of the GDP deflator turns negative.

Second, using the findings of the simulations on the effect on the primary balance, the paper looks at the effects of an inflation shock on debt sustainability. The effect on the debt-to-GDP ratio tends to be more sizeable, due to the denominator effect. Moreover, the larger the initial debt-to-GDP ratio, the more vulnerable a country is to unexpected negative shocks to inflation. This debt sustainability analysis shows that a permanent low inflation shock leads to an average increase in the debt ratio of 11p.p. of GDP over ten years, which implies heightened debt sustainability risks for some countries. The note finds that in case inflation would turn negative, the adverse impact on the fiscal variables would be larger.

1 Introduction

While it is crucial that monetary and fiscal policy authorities are clearly separated in terms of objectives and instruments, it has to be acknowledged that there are strong interdependencies between monetary and fiscal developments.[1] Indeed, both monetary and fiscal policy impact similar key macroeconomic variables (e.g., aggregate demand, real interest rates and risk premia) (Sargent & Wallace 1980, Aiyagari & Gertler 1985, Sims 1988, Walsh 2010). These interdependencies are particularly challenging in the current low inflation and low growth environment. Since 2011 inflation rates across the euro area have fallen gradually on account of a number of factors, and remain below the ESCB's medium-term objective, while the conventional monetary policy instruments have reached the zero lower bound. At the same time, euro-area countries' fiscal positions remain weak following the unsound policies of the past, but also the effect of the financial and economic crisis and the still weak recovery. In most countries, the need for further consolidation remains and there is a risk that persistently low or negative inflation further aggravate the weak fiscal position of euro area sovereigns.

Economic analysis suggests that, *coeteris paribus*, a disinflation shock worsens both the headline and the primary budget balance and increases the debt-to-GDP ratio. The first effect is modest and short-lived, but the second is larger and more persistent.

In the present paper, after reviewing the main channels through which inflation influences public finances, we will shed more light on these effects by looking on a subsample of euro-area countries (Germany, France, Italy, Austria and Greece).

Based on the fiscal forecast models of individual central banks, we find that a 1p.p. temporarily lower inflation rate worsens the primary balance on average by 0.15p.p. of GDP on impact. Furthermore, to the extent that lower inflation passes through to market interest rates (via lower inflation expectations), the ensuing decline in interest payments would have a cushioning effect on the headline balance, which, on average, would deteriorate by about 0.05p.p. of GDP on impact. The effect on the fiscal balances tends to be transitory and to fade away by the end of the third year. Country specific circumstances (e.g., a temporary suspension of indexation mechanisms) may heighten the sensitivity of the fiscal balances to inflation developments and imply a more persistent deterioration. A high debt-to-GDP ratio is another important vulnerability

[1] The separation is needed to avoid that fiscal authorities force central banks into accommodating their policies while disregarding price stability objectives.

factor. Illustrative simulations of the effects of a negative inflation shock are also presented for the case of France.

Low/negative inflation has also implications for debt sustainability. The DSA presented in section 5 finds sizeable effects from low inflation on the debt-to-GDP ratio, especially for countries starting from a high debt-to-GDP ratio. The average increase in the debt-to-GDP ratio is about 11p.p. for a permanent low inflation shock.

A disinflation shock is not a major hindrance to comply with SGP requirements. Given the limited effects of low inflation on public finances, section 6 argues that these are too small to obstruct compliance with SGP requirements. While there is no specific definition in the SGP of a severe economic downturn, should tail risks and deflation materialise, an application of the general escape clause might need to be considered. However, if negative inflation materialises in the absence of a severe economic downturn, the general escape clause will likely not apply.

The effects on public finances are likely to be exacerbated if inflation turns negative. On the fiscal side proper, negative inflation would possibly lead to a more pronounced impact from the downward rigidity of some government spending (e.g., social payments and compensation of employees), hence a stronger deterioration of the fiscal position. However, a full understanding of the effects of negative inflation on public finances is beyond the scope of this note given the uncertainty surrounding its macroeconomic effects. The latter depend, in the first place, on the nature of the inflation shock. If negative inflation reflects a supply-side shock (e.g., a positive technology shock or cost competitiveness improvements) that is not monetarily accommodated, the effect on public finances is positive as the decline in the price level is accompanied by an increase in the actual and natural level of output (Bordo *et al.* (2004)). If negative inflation originates from a collapse in aggregate demand, output and employment would decline given the downward rigidity of nominal input prices, including wages, which reduce firms' margins. Moreover, to the extent that the monetary policy is constrained by the zero lower bound, real interest rates would increase thus further hitting the real economy.[2] In these circumstances, negative cyclical developments are likely to weight significantly on public finances.

The rest of the paper is as follows. In section 2, we discuss in general terms the impact of inflation on public finances, reviewing both the analytics and the available empirical evidence; we highlight three different channels of transmission of the inflation shock to the debt-to-GDP ratio. We then try to measure this impact both separately for each channel (section 3) and globally (section 4) for a subset of European countries. the effects on debt sustainability are also looked at (section 5). In section 6 we draw some policy implications. Section 7 concludes.

2 The effects of inflation on fiscal policy: an overview

According to the empirical literature, changes in the price level may have significant effects on debt dynamics. Aizenman & Marion (2011, 538) find that an unanticipated inflation shock of the order of 6 per cent could reduce the debt/GDP ratio by up to 20 per cent within 4 years. Investigating the impact of inflation on the public debt in the G7 countries, Akitoby *et al.* (2014) find that if "inflation were to fall to zero for five years, the average net debt-to-GDP ratio would increase by about 5 percentage points over the next 5 years".[3] Hall & Sargent (2010) decompose

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[2] In this context, inflation expectations are crucial. If deflation becomes anticipated, than the expectation of a further decline in prices may reinforce the negative output effects. This occurs, for example, when in anticipation of further declines in prices, firms and households postpone investment and consumption choices respectively, this causing a further fall in aggregate demand and a prolonged economic slump. This vicious circle triggers a "deflationary spiral", which however, is not explicitly considered in this note.

[3] The paper simulates the effect of inflation on base money creation (seigniorage) and the erosion the real value of the debt.

the post-war debt reduction in the US into contributions from negative real returns on government bonds, primary surpluses, and growing real income. They find that higher inflation accounted for only 20 per cent of the 85 per cent decline in the debt-to-GDP ratio achieved over the period 1946-1974.

Theoretically, inflation affects fiscal outcomes through a number of channels (Tanzi *et al.*, 1987; Abbas *et al.*, 2013), in particular via: (1) the real debt stock; (2) market interest rates; (3) primary public expenditures and tax revenues.[4]

To illustrate the first channel, one could start from the well-known dynamic debt accumulation equation:

$$\Delta b_t = \frac{i_t - g_t}{1+g_t} b_{t-1} - pb_t \tag{1}$$

where b_t is the debt-to-GDP ratio, i_t is the average nominal (effective) interest rate, g_t is the nominal GDP growth rate, pb_t is the primary balance-to-GDP ratio at time t.

Indeed, equation (1) can be reformulated by expressing the total debt-to-GDP ratio as the sum of b_t^S the portion of debt that is sensitive to inflation (*i.e.,* short-term debt, foreign-currency denominated debt, long-term variable-interest or inflation-indexed debt) and b_t^{NS} the portion which includes only domestic-currency denominated, long-term, non-indexed debt:[5]

$$b_t^{TOT} = b_t^S + b_t^{NS} = \frac{1+i}{1+g} b_{t-1}^S + \frac{1+i^*}{1+g} b_{t-1}^{NS} - pb_t \tag{2}$$

where i is the interest rate on b_t^S, i^* is the interest rate on b_t^{NS}; g is the growth rate of nominal GDP and pb_t is the primary balance.[6] Equation (2) can be further rearranged and expressed as (see Annex 2):

$$b_t^{TOT} = \frac{1+r}{1+n} b_{t-1}^S + \frac{(1+r^*)(1+\pi_t^{\exp})}{(1+n)(1+\pi_t)} b_{t-1}^{NS} - pb_t, \tag{3}$$

where n is the real growth rate, r and r^* are respectively the real exchange rate required by investors in period t–1 on the b^S and the b^{NS} portion of the debt, and π_t^{exp} is the rate of inflation in period t expected by investors in period t–1. The first term on the right hand side of equation (3) captures the contribution to the debt-to-GDP dynamics of the component of debt whose cost is inflation-sensitive. This term does not depend on inflation as it is the sum of the debt outstanding from the previous period, which depends negatively on inflation, and interest payments, which depend positively on inflation. These two opposing effects on the debt-to-GDP ratio cancel out.

To the extent that period t inflation is unexpected, the second term in equation (3), clearly does depend negatively on inflation.

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4 This note abstracts from seignorage revenues. Governments typically receive revenues from the operating profits of the central bank. For the euro area, the "Protocol on the Statute of the European Central Bank" states that ECB profits are distributed in accordance with paid-up shares of member countries in European Central Bank capital. Operating profits broadly originate from the change in the monetary base (seigniorage) as well as interest income (Buiter 2007). Government seigniorage revenues are thus often understood as an inflation tax, *i.e.*, the financial loss of value suffered by holders of currency (e.g., Fischer, 1982). However, seigniorage accounts for a very small percentage of government revenues in industrialised countries (Hilscher *et al*., forthcoming).

5 A more detailed version of this equation is discussed in Akitoby *et al.* (2013).

6 For ease of exposition, we did not take into account that the various components of b_t^{NS} might have different interest rates, and we disregard time sub-indices. The equation also assumes a full Fisher effect. This will be relaxed below.

Moreover, it is worth noting that the real interest rate (r^*) may decrease if inflation increases – this is the second channel mentioned at the beginning of this section.

Indeed, the sensitivity of the debt-to-GDP-ratio to the inflation rate is a function not only of the size and the structure of debt, but also on the pass-through from low inflation to nominal interest rates. In particular, when the pass through from low inflation to the nominal interest rate is 1 (so-called full Fisher effect) the formula for the elasticity of debt to inflation is:[7]

$$\varepsilon_{b_t^{TOT},\pi_t} = -\left(\frac{\pi}{1+\pi}\right)\left(\frac{b_t^{NS}}{b_t^{TOT}}\right). \tag{4}$$

But when the pass-through is less than one, the elasticity is:

$$\varepsilon_{b_t^{TOT},\pi_t} = -(1-k)\left(\frac{\pi}{1+\pi}\right)\left(\frac{b_t^{S}}{b_t^{TOT}}\right) - \left(\frac{\pi}{1+\pi}\right)\left(\frac{b_t^{NS}}{b_t^{TOT}}\right). \tag{4'}$$

where we have defined $(1+i)=(1+r)(1+k\pi_t)$, where $k\leq 1$ ($k=1$ in the full Fisher effect). Equation (4') differs from equation (4) for the first terms on the right hand side. The intuition behind this term is straightforward. With k=1 inflation reduces the debt-to-GDP ratio only via b_t^{NS}. With k<1 also b_t^{S} contributes, because the outstanding-debt effect on b_t^{S} is only partially counterbalanced by the increased interest payments effect. This happens because also the real interest rate r due on b_t^{S} is reduced by inflation, as now the nominal interest rate (i) reacts less than 1-to-1 to π.

Empirical evidence suggest that the pass-through could be lower than one. Several studies (Feldstein & Summers 1978, Ardagna *et al.* 2007, Laubach 2009) find that a 1 percentage point increase in expected inflation leads to an increase in bond yields in the range of 0.1 and 0.3 percentage points. Caporale & Williams (2002), find that inflation expectations play a greater role for interest rates in countries with a history of volatile inflation than in those with a history of low and stable inflation. Similarly, Arslanalp and Poghosyan (2014) argue that for advanced economies the smaller impact of inflation on interest rates could be explained by the relatively low and well anchored inflation expectations in these countries thus diminishing their importance for long-term investors.

To assess the degree to which the Fisher effect is valid for today's Europe, we regressed daily changes in the 10-year overnight index swap (OIS) on daily changes in inflation expectations measured by inflation swap rates at 10-year maturity: the estimated coefficient over the daily period 1 April 2005-25 August 2014 amounts to 0.61, is highly statistical significant and rather stable.

We also performed a more formal multivariate analysis, using a panel regression with country fixed effects and controlling for the level of government debt, expected real GDP growth 1-year ahead, the sovereign bid-ask spread, and a proxy of the redenomination risk premium (the USD/EUR option price at 1-year maturity). We found in this case a pass-through from the 10-yr OIS rate to the 10-yr sovereign yield is close to 1 (estimated for a cross-section of the largest 10 euro-area countries over the period Oct 2003 to July 2014, monthly frequency; the results are supported by a Pedroni residual cointegration test, which suggests that the residuals of the panel regression are stationary).

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[7] For ease of exposition we assume here that the primary balance does not react to unexpected inflation shock. This effect will be discussed in more detail in the following sections.

All in all, our results[8] suggest that the short-term pass-through from long-term expected inflation to long-term nominal sovereign yields is quite high, and the Fisher hypothesis can be considered –at monthly frequencies – a good approximation of reality

Concerning the third channel (primary balance), the overall negative effect on the primary balance can be considered limited and transitory. On the spending side, a decrease in the prices of goods and services reduces nominal intermediate consumption and government investment. It also reduces spending on compensation of public employees, pensions and other transfers, as long as those payments are indexed to price developments. Barro (1979) and Dwyer (1982) argue that in order to maintain the same anticipated real amount of spending, governments adjust their deficit to unanticipated inflation rate changes. However, in practice public expenditures are unlikely to adjust to inflation automatically. Expenditures, including discretionary spending, are decided in a discretionary manner every year by government entities in the context of the budgetary process. Public wages and transfers are usually fixed for even longer periods, and indexation rules may apply with a lag. Unanticipated lower inflation may thus cause expenditures to increase as a ratio to GDP, at least in the short term.

Inflation can affect tax revenues on account of (nominal) fiscal drag (Kremer, 2006; Creedy and Gemmell, 2007; Lee, 2011). Progressive income taxes imply that increases in wages in line with inflation increase government real tax revenues by pushing nominal incomes into higher tax brackets ("bracket creep"). A deceleration in the rate of inflation mitigates this effect. Negative inflation can lead to a reversal of the fiscal drag and may – where nominal wages start falling – imply a fall in real tax revenues. Heinemann (2001, 543) finds that in many OECD countries with strongly progressive tax systems, inflation is "helpful in increasing revenues from individual income taxes and social security contributions" on account of the fiscal drag. Immervoll (2005) in a study of the tax systems in Germany, the Netherlands and the U.K. finds that the bracket creep has a substantial effect on individual tax burdens in the absence of automatic inflation adjustment mechanisms. At the same time, inflation has a negative effect on real revenues for taxes with a significant collection lag. Inflation automatically reduces real revenues for taxes with a considerable lag between the taxable event and the moment the tax is actually paid (Escolano 2010).

3 Public finances in a low (negative) inflation environment: a look at selected euro-aurea countries

The effect of an unexpected disinflation shock on public finances depends on the structure of government spending, the tax system and the structure/size of government debt. This section focuses on selected euro-area countries (Germany, France, Italy, Austria and Greece) for which detailed information on key fiscal aggregates (*i.e.,* primary expenditures, revenues, interest payments and the debt stock) and how they are likely affected by inflation developments is available.[9] After summarising the key transmission channels, a model-based simulation of the impact of low inflation on public finances is obtained using the fiscal forecast models of the NCBs. Finally, an illustrative quantification of the effects of negative inflation for the case of France is provided.[10]

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[8] Results are available from the authors upon request.

[9] This information has been collected by the working team on the basis of a detailed questionnaire prepared and filled in by the NCBs experts participating in the working team.

[10] The model based analysis presented in this section, however, is a partial analysis as it is not based on a fully consistent macroeconomic scenario.

3.1 The Primary balance channel (1): primary expenditure

Indexation of government spending is common to all countries under consideration and CPI inflation is the most commonly used index (see Table 1). The share of total spending which is indexed ranges from 29 per cent (13.3 per cent of GDP) in Germany, to 60.8 per cent (31.9 per cent of GDP) in Italy. In Germany, however, less than 5 per cent of total spending is directly indexed to inflation. Since 2009-2010, however, indexation mechanisms have been suspended either entirely or partly in both Italy and France in the context of the ongoing consolidation efforts of the respective governments. As a result, the effective indexation is smaller (for Italy it falls to 21 per cent of GDP). In Greece all indexation mechanisms operating before the country entered the economic adjustment programme have been suspended.

Discretionary spending, (e.g., intermediate consumption and public investment) is usually budgeted in nominal terms at the beginning of the budgetary process. Budgeting is done in a top-down manner (*i.e.,* spending envelopes across entities are decided centrally by the Minister of Finance) in France, Italy and Germany, and bottom-up (*i.e.,* based on consultation with various entities) in Austria and Greece. Spending envelopes are usually set in nominal terms and in France, Germany and [Italy], they are based on expected inflation developments, whereas in Austria a medium-term path is set for the period t+4 which, however, is not linked to inflation developments. Unexpected changes in inflation usually transmit to this type of spending with a time lag, because most of these expenditures are controlled by lower levels of government. They usually adjust their spending behaviour only in the medium-term, while relying on budget-deficits in the short-term.

3.2 The Primary balance channel (2): Tax revenues

Personal income taxes are levied progressively in all countries under consideration, though only France legally indexes the tax brackets of its personal income tax to inflation (of year t–1) thus limiting the fiscal drag to real component (see Table 2) . However, such indexation has been suspended for 2012 and 2013 for consolidation reasons, whereas for the remaining countries in our sample, both a nominal and real fiscal drag effect is at work. The overall fiscal drag typically amounts to revenues of up to 0.2 per cent of GDP annually over the last 15 years.

Corporate income taxes are progressive only in Greece and France but no bracket indexation is foreseen. For these two countries the nominal fiscal drag has been small over the recent past. This is due to the limited number of tax brackets foreseen by law in both countries(two). Inflation plays a role in corporate taxation even if corporate profits are taxed proportionally. In all countries considered here, depreciation allowances are based on historic costs; thus inflation reduces the real value of depreciation allowances and increases the effective tax rate on corporations indirectly.

Social security contributions, which share the same tax bases as personal income taxes, are typically levied proportionally. With the exception of Greece, in all countries there are caps on the maximum amount of social security contributions to be paid. As inflation would push more and more people over the cap limits, *i.e.,* exempting them from contributions, all countries in our sample legally index the caps to inflation developments.[11] These adjustments allow for stability of real social security contributions.

Indirect taxes, such as VAT, are usually levied proportionally on prices (*ad valorem* method of taxation). Excise duties, are levied proportionally on quantities (except for tobacco taxes which

[11] While Germany and Austria adjust the caps (and also minimum contribution levels) to wage increases in t–2, France adjusts according to wage increase in t–1 and Italy takes price increases in t–1 into account. Hence, Italy implicitly spares real wages from higher social security contributions.

Table 1

Indexation Structure of Main Government Spending

(percent)

Expenditure Items	Share in Total Expenditures (2013 data, percent)	(percent of 2013 GDP)	Indexation Mechanism (Y/N)	Index Used for Indexation	Is Mechanism Working at Present?
Pensions					
Germany	24.4	11.2	Y	Per capita wage increase in *t*–1	
France	***24***	**14.1**	***Y***	***Forecasted CPI excl. tobacco***	***Basic pensions frozen in 2015; supplementary pensions progress less than inflation***
Italy	***35***	**18.3**	***Y***	***Forecasted CPI excl. tobacco***	***Partial indexation for pensions > 3000 EUR/month***
Austria	***28***	**14.7**	***Y***	***Realised CPI***	
Greece	**26**	**15.2**	**Y**	**Forecasted CPI**	**Suspended since 2009**
Social benefits					
Germany	4.6	2.1	Y	Private sector wage growth and past CPI	
France	***11***	**6.5**	***Y***	***Forecasted CPI (excl. tobacco)***	
Italy	***5.3***	**2.8**	***Y***	***Wages and CPI***	
Austria	***2.8***	**1.5**	***Y***	***Wages, CPI***	
Greece	**2.00**	**1.18**	**Y**	**Forecasted CPI**	**Suspended since 2009**
Compensation of employees					
Germany	17.5	8.0	N		
France	23	13.5	Y	Index point not automatically related to inflation	Yes, until 2017 will be frozen
Italy	***20.5***	**10.7**	***Y***	***Government CPI inflation target***	***Yes, until 2015 will be frozen***
Austria	18.3	9.6	N		
Greece	**20.4**	**11.9**	**Y**	**Forecasted CPI**	**Suspended since 2009**

Source: authors' elaboration based on ESA1995 data. Note: figures in bold represent those items which are directly indexed to inflation.

Table 2

Main Taxes and Indexation of Tax Brackets in Selected Euro-area Countries

Type of Taxes and Indexation of Tax Brakets				
	PIT	**Corporate**	**SSC**	**Excise duty**
EL	**progressive /NO**	**progressive/NO**	**proportional**	**proportional on quantity**
DE	**progressive /NO**	**proportional/NO**	**proportional/indexation of caps**	**proportional on quantity**
FR	**progressive/yes**	**progressive/NO**	**proportional (progressive)/indexation of caps**	**proportional on quantity**
IT	**progressive /NO**	**proportional/NO**	**proportional/indexation of caps**	**proportional on quantity**
AT	**progressive /NO**	**proportional/NO**	**proportional/indexation of caps**	**proportional on quantity**

Source: authors' elaboration.

incorporate also a price component). Thus, assuming no behavioral changes, price developments should not affect nominal excise tax revenues. In real terms, however, and in percent of GDP these tax revenues are gradually eroding over time without any discretionary adjustment. For the countries in the sample, these represent approximately 5 per cent of overall tax revenues, which are not legally linked to any price developments. Moreover, the same phenomenon concerns recurring real estate taxation, in instances where it is based on cadastral values, as opposed to market values. This is the case for Italy, Austria, France and Germany.

Table 3 quantifies the nominal fiscal drag for the wage tax and excise duties[12] and shows that for 2013 it is overall very limited. For the purpose of this analysis, the focus is only on the nominal revenue effects of fiscal drag on wage tax for 2013[13] and on excise duties. The underlying method used to calculate the nominal fiscal drag is detailed in the Annex 2[14] and the reference price index used is the private consumption deflator. The nominal fiscal drag from the wage tax in 2013 was positive for all countries that experienced an increase in the price deflator and was comprised between 0.07 and 0.14 per cent of GDP, whereas it was negative, though small in Greece owing to the fall in the price deflator. Differences in the change in the price deflator, largely explain the observed cross country differences in the fiscal drag.

The fiscal drag from excise taxes was small across countries but the sign of the fiscal drag goes in opposite direction to the change in the price deflator. Since excise taxes are levied on quantities, the calculation of the nominal fiscal drag assumes that the tax base is linked to real private consumption and not to nominal private consumption. The elasticity of revenues from excise taxes to changes in real private consumption is assumed to be smaller than 1. As a result, in

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[12] The WGPF provides information on fiscal drag using the disaggregated approach for income tax. However, this source only allows quantifying the combined effect of real and nominal changes on fiscal drag. If, however, the aim is to examine the impact of low inflation on public finances, quantifying the general fiscal drag is a relatively ineffective approach.

[13] This analysis takes no account of a further important effect of inflation on the size of the real tax burden, for where taxation is determined in line with nominal investment income, higher inflation generally results in the tax levied on the real return being well above the nominal tax rate. In this regard, the degree of divergence between the nominal rate and the effective real tax burden depends on the ratio of the nominal interest rate to the real interest rate, although other factors (in particular, depreciation allowances) also exert an influence. The following example illustrates the effect in question: If, say, the tax rate is 50 per cent, the nominal interest rate is 2 per cent and inflation stands at 0 per cent, this leaves a nominal and real return after tax of 1 per cent while tax revenue also amounts to 1 per cent. By contrast, if the nominal interest rate is set at 5 per cent, with inflation at 3 per cent (the real interest rate remaining unchanged at 2 per cent), the nominal return after tax amounts to 2.5 per cent whereas the real return after tax is –0.5 per cent and tax receipts stand at 2.5 per cent. This effect, which impacts on the progressive tax regime but also on proportional tax rates, can be quite considerable. Moreover, it can lead to severe distortions in the economy that are a drag on potential growth. However, it is not taken into consideration here when calculating fiscal drag.

[14] The calculation of the fiscal drag is based on the implicit assumption that a change in inflation induces an equally large percentage change in nominal wages. In addition, the relative significance of the price effect for income tax (relative to a proportional tax regime) depends on the choice of price index.

Table 3

Fiscal Drag that Is Due to Changes in the GDP Deflator (2013)

	Fiscal Drag on Wage Tax			Fiscal Drag on Excise Taxes			Overall Fiscal Drag			Change in Pric Deflator
Country	bn EUR	%GDP	Sensitivity to 1p.p. change in deflator	bn EUR	%GDP	Sensitivity to 1p.p. change in deflator	bn EUR	%GDP	Sensitivity to 1p.p. change in deflator	%
AT	0.42	0.14	0.06	-0.15	-0.05	-0.02	0.27	0.09	0.04	2.20
DE	1.93	0.07	0.06	-0.86	-0.03	-0.02	1.07	0.04	0.03	1.25
FR										
GR	-0.10	-0.05	0.03	0.1	0.05	-0.03	0	0	0.00	-1.5
IT	1.63	0.10	0.08	-0.58	-0.04	-0.03	1.05	0.07	0.05	1.32

Source: authors' elaboration.

2013, the fiscal drag from excise taxes due to a change in the deflator was negative in all countries, except Greece where the fiscal drag was positive due to a fall in the deflator.[15]

3.3 The debt ratio and the interest-rate channels

As illustrated in section 2, an unexpected increase in inflation reduces the debt-to-GDP ratio via the impact on the outstanding stock of debt and the cost of servicing this debt in addition to its effect via the primary balance (see equation 1, Section 2).[16] The share of the debt which is not sensitive to inflation developments differs significantly across countries (see Annex 2 and Table 8 for more details) thus leading to different degree of sensitivity of the debt ratio to inflation shocks.

Table 4 below illustrates the results of applying the formula derived in section 2 to individual countries. Italy is the country with the largest sensitivity to changes in inflation (0.9p.p. of GDP), owing to the high debt ratio. Greece, on the other hand, records the lowest impact on the debt ratio (0.3p.p.) owing to the very low elasticity, which in turn depends on the very low share of debt which is not sensitive to the inflation rate. For the other countries the effect is in between these two extremes (Table 5).

This sensitivity becomes larger under the assumption of a partial pass-through from inflation to interest rates. Applying the formula in (4') and assuming a value for k=0.6 (see section 2) we obtain the new values for the elasticity and the impact of lower inflation on the debt ratio. As expected, the sensitivity of the debt-to-GDP ratio to the same decline in inflation is larger than in the k=1 case. However, it turns out that the effects are not quantitatively very different. The debt-to-GDP ratio increases by 1.1 percentage points of GDP in Italy, 0.8p.p. in France, 0.6p.p. in Austria and 0.6p.p. in Germany. The only exception is Greece, where the increase in debt is now 0.9 percentage points (as opposed to 0.3 percentage points in the full-Fisher scenario). This is due to the fact that Greece is the only country in which b_t^S is much bigger than b_t^{NS}.

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[15] Finally, the so-called Tanzi effect (Tanzi 1977), which refers to the inflation-induced reduction in real tax income due to collection lags is likely to be not significant in ESA terms. In most countries tax-prepayments should avoid collection lags and moreover both ESA 95 and ESA 2010 follow the accrual principle.

[16] As in the rest of the paper, we do not consider here the seigniorage channel.

Table 4

Effects of a Decrease of EA Inflation from 1.3 to 0.3 per cent

FULL FISHER EFFECT (k=1)	**GERMANY**	**FRANCE**	**ITALY**	**AUSTRIA**	**GREECE**
Debt-to-GDP ratio (%) (d_{tot})	78.4	93.5	132.6	74.0	175.1
share of long-term, non-maturing debt (b_t^{NS}/b_t^{TOT})	0.66	0.75	0.68	0.88	0.19
Inflation in 2015	1.3%	1.3%	1.3%	1.3%	1.3%
Elasticity	-0.008	-0.010	-0.009	-0.011	-0.002
Debt-to-GDP ratio with 1p.p. lower inflation	78.9	94.2	133.5	74.6	175.4
Change in debt	***0.5***	***0.7***	***0.9***	***0.6***	***0.3***
PARTIAL FISHER EFFECT (k=0.6)					
share of short-term, variable interest rate debt (b_t^{S}/b_t^{TOT})	0.34	0.25	0.32	0.12	0.81
second elasticity	-0.002	-0.001	-0.002	-0.001	-0.004
Elasticity	-0.010	-0.011	-0.010	-0.012	-0.007
Debt to GDP ratio	79.0	94.3	133.7	74.7	176.0
Change in debt	***0.6***	***0.8***	***1.1***	***0.7***	***0.9***

4 Country specific simulations on The effect of inflation on the primary balance

This section aims at providing a stylised assessment of the transmission mechanisms from inflation to revenues and expenditures using the fiscal forecast models of individual central banks. First, the results for a low inflation shock are presented, (*i.e.,* –1p.p. lower inflation vs. baseline). Second, the analysis looks at the effects on public finances in the case of a negative inflation rate (i.e., GDP deflator growth rate of –1 per cent). The main assumptions these simulations are in Annex 4.

4.1 A disinflationary shock

The effects of a –1p.p. temporary shock to the GDP deflator on the primary balance and the headline balance are illustrated in Table 5. This corresponds to a permanent shock to the level of the deflator, whereas it is assumed that the growth rate reverts to the baseline already in year t+1. The main transmission channels of the low inflation shock are country specific depending on the assumptions on the transmission of the shock to wages and salaries, the timing of indexation and the possibility that in some countries existing indexation mechanisms are temporarily frozen as discussed in section 4.1.

The average deterioration in the primary balance is 0.15p.p. of GDP on impact though there are important differences across countries (*i.e.,* 0.3p.p. in Italy vs. 0.1 per cent of GDP in Germany and Greece). These effects are in line with the findings from a panel regression for a sample of EU countries based on the fiscal reaction function literature (see Box 3). The deterioration is due to total revenues declining, in nominal terms, more than nominal primary expenditures. Both discretionary and non-discretionary spending adjust with a lag to the lower inflation environment, thus causing the primary expenditure-to-GDP ratio to increase on impact. The reduction in primary spending in the first year is influenced by assumptions regarding the pass-through of inflation developments to public and private wages. In Austria, for example, both private and public sector wages adjust with a lag to lower inflation, as wages are usually agreed in year t–1 for the following period. In France, Italy and Greece, public wages do not adjust to lower inflation as existing indexation mechanisms are currently suspended. This introduces an element of downward rigidity,

whereby a lower realised inflation rate results in lower realised budgetary savings compared to a baseline scenario with higher expected inflation rates, hence higher savings thanks to the wage freeze. Other spending categories also adjust with a lag, though by different degrees. In Germany, Italy and Greece the pass-through from lower inflation to intermediate consumption is higher than in Austria and France. On the revenue side, direct taxes tend to decline in line with GDP in Germany and Austria, and more than in other countries, whereas the reaction of indirect taxes is more subdued. In the case of Austria this reflects the fact that indirect taxes depend only partially from private consumption. In Italy, France and Greece indirect taxes decline more in line with GDP. Finally, social security contributions are relatively less affected by lower inflation in the first year in all countries reflecting the partial pass-through from low inflation to total wages.

In Germany and Austria the primary balance returns to the pre-shock baseline by the end of the three-year simulation horizon. In Italy the gap to the baseline declines progressively, whereas it takes longer to converge in France and Greece. In Austria both revenues and primary expenditures fully adjust downward by the end of the horizon. In Germany, revenues and primary spending in nominal terms decline in proportion by a similar amount, so that the impact on the primary balance is almost zero. In Italy, the primary balance in the first year deteriorates more than in the other countries, owing mostly to the fact that pension expenditures[17] adjust with a lag to lower inflation. The gap to the baseline shrinks in the second year and widens slightly by the end of the projection horizon due to a more pronounced decline in direct taxes and social security contributions. In Greece and France, the end of period deterioration in the primary balance is higher than the one recorded on impact (0.2p.p. of GDP and 0.1p.p. of GDP respectively). This owes to a more rigid structure of primary spending given that in addition to wages and salaries, also social transfers are assumed not to react to the low inflation shock. As a result, the freezing of the indexation mechanisms introduced in the context of the recent consolidation efforts, introduces an element of downward rigidity in government spending (at unchanged policy), which has persistent effects on the primary balance in presence of a disinflation shock.

If lower inflation feeds through into lower interest rates on newly issued debt, it has a cushioning effect on the headline budget balance, which deteriorates on impact by 0.05p.p. on impact. If lower inflation passes-through to lower interest rates, via lower inflation expectations, this will reduce the cost of newly issued debt, thus cushioning the adverse effects of lower inflation on the primary balance. This beneficial effect depends on the degree of pass-through from low inflation to interest rates (higher in the case of full pass-through) and the maturity structure of debt. In the case of Germany, the savings related to lower interest payments more than offset the deterioration in the primary balance, thus leading to an improvement of the budget balance of 0.1p.p. In the outer years, this effect fades away since interest rates go back to the pre-shock level given the temporary nature of the inflation shock. For the other countries, the offsetting effect is less strong, but still positive. Overall the dynamics of the headline budget balance are similar to what described above for individual countries. However, it has to be noted, that to the extent that the shock to inflation is only temporary and inflation expectations are not affected, this beneficial impact from lower interest payments is likely not to materialise, or to materialise to a smaller extent.

4.2 A negative inflation shock

A negative inflation shock has more adverse consequences for public finances essentially via the negative effect on economic growth and a higher rigidity in government spending. Simulating

[17] In 2013 pension expenditures in Italy amounted to 35 per cent of total spending.

Table 5

Effects of –1p.p. Lower Inflation on Main Fiscal Variables

Deviations from baseline	Germany			France			Italy			Austria			Greece		
	t	t+1	t+2	t	t+1	t+2	t	t+1	t+2	t	t+1	t+2	t	t+1	t+2
	p.p. of GDP														
Budget balance	0.08	0.02	0.02	-0.04	-0.13	-0.15	-0.11	-0.02	-0.11	-0.14	-0.10	-0.03	-0.05	-0.17	-0.16
Primary balance	**-0.05**	**-0.02**	**-0.02**	**-0.15**	**-0.17**	**-0.19**	**-0.27**	**-0.13**	**-0.16**	**-0.17**	**-0.14**	**-0.06**	**-0.08**	**-0.12**	**-0.11**
Total expenditures	0.14	0.18	0.16	0.31	0.32	0.31	0.22	0.05	0.10	0.39	0.11	0.00	0.27	0.32	0.31
Primary expenditures	0.27	0.23	0.20	0.41	0.36	0.36	0.38	0.16	0.15	0.42	0.15	0.03	0.30	0.27	0.26
Total receipts	0.22	0.20	0.18	0.26	0.19	0.16	0.11	0.03	-0.01	0.25	0.01	-0.03	0.22	0.16	0.15
	% deviations from baseline level														
Total receipts	**-0.62**	**-0.65**	**-0.71**	**-0.50**	**-0.64**	**-0.69**	**-0.76**	**-0.94**	**-1.00**	**-0.50**	**-0.98**	**-1.06**	**-0.53**	**-0.65**	**-0.66**
o.w.: Direct taxes	-1.09	-1.04	-1.08	-0.27	-0.80	-0.90	-0.20	-0.56	-0.65	-1.01	-1.47	-1.61	-0.14	-0.59	-0.64
Indirect taxes	-0.71	-0.75	-0.77	-0.98	-0.97	-0.97	-0.98	-0.97	-0.97	-0.54	-0.74	-0.78	-1.00	-1.00	-1.00
Social contributions	-0.13	-0.23	-0.35	-0.30	-0.36	-0.42	-0.26	-0.33	-0.39	0.00	-0.90	-1.03	0.00	0.00	0.00
Total expenditures	**-0.68**	**-0.59**	**-0.65**	**-0.46**	**-0.43**	**-0.44**	**-0.60**	**-0.90**	**-0.78**	**-0.24**	**-0.78**	**-1.00**	**-0.43**	**-0.30**	**-0.31**
o.w.: Compensation of employ	-0.13	-0.24	-0.37	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	-0.80	-1.00	0.00	0.00	0.00
Intermediate consumptio	-0.75	-1.00	-1.00	-0.50	-1.00	-1.00	-1.00	-1.00	-0.99	-0.50	-1.00	-1.00	-1.04	-1.06	-1.06
Social transfers in kind	-0.42	-0.49	-0.58	0.00	0.00	0.00	-0.50	-0.50	-0.50	-0.30	-0.80	-1.00	0.00	0.00	0.00
Social benefits	-0.43	-0.47	-0.53	-0.11	-0.11	-0.11	0.00	-1.00	-1.00	0.00	-0.44	-0.89	-0.27	-0.27	-0.27
Interest payments	-5.63	-1.20	-1.30	-5.53	-2.87	-3.11	-4.20	-3.20	-2.00	-2.41	-2.48	-2.19	-1.60	0.00	0.00
Public Investment	-0.50	-1.00	-1.00	-0.50	-1.03	-1.06	-0.40	-1.00	-1.00	-0.50	-1.00	-1.00	-0.43	-1.12	-1.04
Nominal GDP growth	***-1.00***	***0.00***	***0.00***	***-1.00***	***0.00***	***0.00***	***-1.00***	***0.00***	***0.00***	***-1.00***	***0.00***	***0.00***	***-1.00***	***0.00***	***0.00***
Nominal GDP	***-1.00***	***-1.00***	***-1.00***	***-1.00***	***-1.00***	***-1.00***	***-1.00***	***-1.00***	***-1.00***	***-1.00***	***-1.00***	***-1.00***	***-1.01***	***-1.01***	***-1.01***

Source: authors'elaboration.

the effects on public finances when the GDP deflator growth rate turns negative is particularly challenging given the uncertainty surrounding the macroeconomic effects of negative inflation and the possibility that threshold effects governing the reaction of the main macroeconomic variables operate. Nonetheless, some tentative assumptions can be made in order to illustrate how a negative inflation rate would transmit to public finances.

When inflation turns negative for a protracted period, real economic activity is adversely affected owing to the (likely) downward rigidity of input prices and the (likely) decline in real private consumption. These factors would lead to a decline in firms' gross operating surplus, hence the major tax bases. In presence of negative inflation, it is plausible to assume that private sector wages are downward rigid and that the negative inflation does not pass-through to nominal interest rates,[18] thus causing an increase in the real interest rate. Moreover, it is also plausible to assume that real private consumption falls in response to negative inflation essentially because consumers observing negative inflation postpone their consumption choices to the future. The rigidity of input prices, the fall in private consumption and the contraction in economic activity that follows leads to a decline in firms' gross operating surplus. As a result, the main tax bases start to contract with negative consequences for tax revenues. Moreover, spending for compensation of employees and other social spending, including unemployment benefits, are also unlikely to fall in line with negative inflation, thus leading to a further worsening of the budget balance. Nominal interest payments are unchanged as there is no effect on nominal interest rate, including those on inflation indexed bonds (the payments on the returns is not diminished when inflation realizations are negative; inflation indexed bonds are set in a way that prevent bonds holder's against the risk of deflation).

Against this background, this section presents some illustrative simulations for the case of France taking as a starting point the low inflation scenario discussed above. It is assumed that an additional shock of –1p.p. to the GDP deflator growth rate occurs, such that the growth rate of the GDP deflator is –1 per cent (as the GDP deflator growth in the pre-low inflation shock (*i.e.,* baseline was 1 per cent). The simulations presented in this section aim at illustrating the transmission mechanisms of negative inflation to public finances. For this purpose it is assumed that the macroeconomic effects of negative inflation are as described above, though it may be argued that in presence of a temporary shock such effects could be less pronounced. Table 6 illustrates the results of the incremental effect on the fiscal balances (compared to the low shock scenario discussed above) when the growth rate of the GDP deflator turns negative.

In this scenario, revenues will decrease as the result of the lower tax bases due to fall in prices but also to the contraction of economic activity. Indeed, unlike in the low inflation scenario, in this case it is assumed that negative inflation has consequences for the real economy via a fall in private consumption will of 0.2 per cent, which translates into a decline in real GDP of 0.1 per cent. The fall in direct taxes reflects essentially the decrease of corporates' taxes, due to the fall of their profits. In year t+2, the primary balance (as percent of GDP) will be lower by –0.22pp compared to low inflation shock as a result of lower revenues (compared to low inflation, primary expenditures will be slightly affected by an increase of unemployment starting in year t+1). The decrease of social security contributions is limited due to the assumed downward rigidity of wages. The budget balance deteriorates more than in the case of "low inflation" as interest payments are not affected by the decline in the rate of inflation and the additional financing needs related to the higher budget deficit as well as the maturing debt are financed at unchanged interest rates.

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[18] On the other hand, it could be assumed that wages could be lowered via cutting extra payments and allowances and by increasing working time. Regarding interest rates, it the real interest rate is sufficiently positive, nominal interest rate could still be reduced even if inflation is negative. Both these factors would mitigate the negative effect on the fiscal balances. However, these effects are not explicitly taken into consideration in this note.

Table 6

Additional Impact on the Budget Balance when GDP Deflator Growth Rate is –1 per cent

Deviation from Low Inflation Scenario	FRANCE		
	T	T+1	T+2
Budget balance (p.p. of GDP) *	–0.17	–0.24	–0.25
Primary balance (p.p. of GDP)	**–0.15**	**–0.21**	**–0.22**
Total expenditures (p.p. of GDP)*	0.53	0.50	0.50
Primary expenditures (p.p. of GDP)	0.51	0.48	0.47
Total receipts (p.p. of GDP)*	0.36	0.26	0.25
Total receipts (percentage change from low inflation level)	–0.52%	–0.70%	–0.72%
Of which: Direct taxes	–0.29%	–0.94%	–1.00%
Indirect taxes	–1.17%	–1.16%	–1.15%
Social contributions	–0.15%	–0.25%	–0.25%
Total expenditures (percentage change from low inflation level)	–0.26%	–0.30%	–0.30%
Primary expenditures	–0.27%	–0.32%	–0.32%
Of which: Compensation of employees	–0.01%	0.00%	0.00%
Intermediate consumption	–0.50%	–1.00%	–1.00%
Social transfers in kind	0.00%	0.00%	0.00%
Social benefits	–0.11%	–0.02%	–0.02%
Interest payments	0.00%	0.14%	0.35%
Public Investment	–0.50%	–1.03%	–1.06%
Nominal GDP growth	–1.10%	0.00%	0.00%
Nominal GDP	–1.10%	–1.10%	–1.10%

Overall, a negative growth rate of the GDP deflator is likely to induce an additional deterioration of about 0.2p.p. of GDP of both the headline and the primary balance at end-period. If taken together with the low inflation scenario, the decline in the GDP deflator by 2p.p. and the non-linearities associated to the fact that its growth rate turns negative, would cause a deterioration of the budget balance of about 0.4p.p. of GDP by the end of the third year compared to the baseline, with a similar time profile as discussed previously.

5 Debt sustainability analysis

The DSA simulations take as a starting point the benchmark scenario as per the 2014 Public Finance Report and quantify the debt impact of three types of inflation shocks:

1) **A permanent shock of 1p.p. lower GDP deflator growth** (compared to the path embedded in the benchmark) over the entire simulation horizon starting with 2015. The inflation shock is considered to fully surprise economic agents and governments the first years (unanticipated shocks). Thereafter, it is gradually, over a period of three years, feeding-through expectations.
2) **A temporary shock of 1p.p. lower GDP deflator growth for 3 years (2015-2017),** followed by gradual linear convergence over 5 years (2018-2022) to the path in the benchmark (reaching the GDP deflator growth of the benchmark in 2022).
3) **A deflationary shock**: country-specific shocks calibrated to obtain a negative GDP deflator growth of –1 per cent for 3 years (2015-2017), thereafter convergence to the benchmark path in 5 years.

In all the above scenarios, the price level is permanently lower.

It is assumed that fiscal authorities do not implement any discretionary policy measures in reaction to the adverse environment. This allows isolating the impact of inflation shocks on the debt dynamics. The results are derived taking into account a partial reaction of fiscal, macro and financial variables to the inflation shocks in line with the findings of the current note. In this respect, three main channels[19] are captured:

First, a drop in the rate of inflation increases the **real value of government debt** directly by reducing nominal GDP (the so-called denominator effect, *i.e.,* the debt-to-GDP ratio increases ceteris paribus).

Second, the slowdown in inflation may adversely affect the **primary balance** to the extent that nominal government spending is downwardly rigid and via lower fiscal drag (*i.e.,* nominal revenues increase as higher inflation pushes incomes into higher tax brackets). For the purpose of the current simulations, the results of the empirical analysis, *i.e.,* an adverse impact of lower inflation on primary balance of 0.1p.p. per year (see Box 3) is considered as a starting point.

Third, the slowdown in inflation is likely to be reflected in a gradual adjustment of **nominal interest rates** beyond what implied by the credit risk premia. For a given level of spreads between government bond yields, a reduction in nominal interest rates is more likely to occur if the low inflation shocks occur throughout the euro area, as this is likely to be associated with the expectation of a lower path of current and future central bank interest rates. The assumptions for the pass-through of an inflation shock to the marginal interest rate (for new government debt) are in line with the empirical finding of Box 2. For the current simulations and in line with the practise in the PFR, the deterioration in fiscal fundamentals resulting from a lower inflation environment is translated into higher sovereign bond spreads (25 bp, and respectively 4 b.p. for every 1p.p. increase in the deficit and the debt-to-GDP ratios). For the three DSA shock scenarios, the assumptions above are translated as follows:

1) Permanent shock scenario:
   - Primary balance-to-GDP: deteriorates through the structural component (exogenous variable) by 0.1p.p. per year for three years (period during which the shock is unanticipated). Thereafter, no reaction is considered beyond the denominator effect.

[19] The slowdown in inflation may also affect potential output growth, with the sign of this effect being, however, unclear a priori and thus not taken into account in the simulations. Hence, on the one hand, a slowdown in inflation may lead to an increase in output growth in countries undergoing rebalancing through an improvement in competitiveness (rebalancing effect). Moreover, other things equal, lower inflation reduces the allocative distortions caused by (nominal) taxation of interest income. Therefore, savings, the capital stock and potential growth could be higher. On the other hand, in presence of low inflation, downward rigidities (especially in wages) can become binding, reducing employment and real activity, which through hysteresis could be transmitted to potential GDP. Moreover, a euro-area wide low inflation environment would make more difficult for countries with external imbalances to regain price and wage competitiveness, especially in the presence of downward rigidities.

- Marginal Interest rates: A pass-through to interest rate of 0.6p.p. is considered for the first year of the shock (2015) across the whole yield curve (an alternative is to have different pass-through effects, *i.e.,* starting at 1 for very short-term debt and converging to 0.6 for 10-year maturities and above). Thereafter, a full pass-through is ensured by the end of the simulation period (2024) through a gradual linear convergence. Marginal interest rates remain somewhat above the benchmark at the end of the simulation horizon due to the higher risk premia.

2) Temporary shock scenario:
   - Primary balance-to-GDP: deteriorates through the structural component (exogenous variable) by 0.1p.p. per year for three years (2015-2017). Thereafter, a symmetric improvement of the structural balance is ensured over the next 3 years (2018-2020).
   - Marginal Interest rates: A pass-through to interest rate of 0.6p.p. is considered for the first year of the shock (2015) across the whole yield curve. Thereafter, a full pass-through is ensured by the end of the simulation period (2024) through a gradual linear convergence. Marginal interest rates remain somewhat above the benchmark at the end of the simulation horizon due to the higher risk premia.
3) Deflationary shock:
   - Primary balance-to-GDP: Given the likely higher pressure from downward expenditure rigidities, the primary balance-to-GDP deteriorates through the structural component (exogenous variable) by the specific share of expenditure subject to inflation indexation (wage bill and social transfers). As above, the impact is maintained only for a period of 3 years.
   - Marginal Interest rates: A pass-through to interest rate of 0.6p.p. is considered for the first year of the shock (2015) across the whole yield curve and then it gradually converges until the marginal interest rates hit the lower bound. Marginal interest rates remain more significantly above the benchmark at the end of the simulation horizon due to the higher risk premia.

Table 7 illustrates the DSA simulations for the five countries considered in this note.

The effects on the debt-to-GDP ratio to the 2024 horizon are sizeable especially for the countries that start with a high debt-to-GDP ratio. In all scenarios, in the absence of discretionary measures in response to the shock, the average headline budget balance deteriorates somewhat over the simulation horizon compared to the baseline. In the lower inflation shock, the decline in the debt servicing costs is not sufficient to compensate for the assumed deterioration of the primary balance, as the permanent decline in the marginal interest rates is offset, at least partly, by the increase in the stock of debt which feeds into higher risk premia. For the temporary shock the deterioration in the headline budget balance is larger than for the permanent shock. This owes essentially to the fact that interest payments savings on account of permanently lower inflation do not materialise, whereas the increase in the debt stock weighs on debt servicing costs. In the case of Greece, the debt service costs increase due to confidence effects related to the relatively higher-than-benchmark debt level. Though the size of shocks is not comparable, in relative terms, the debt increasing effect is the largest in the case of a deflationary shock due mainly to the size of the shock but also to the assumed rigidities on the expenditure side in line with what described in the previous section.[20]

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[20] In all countries the size of the shock is larger in the negative inflation scenario: ranging between –2.5 pp in 2015 and –2.8 pp in 2017 for AT, –2.8 and –3.3 for DE, –2.3 and –2.5 for FR, –1.3 and –2.0 for GR and –2.5 and –2.7 for IT. In Greece, which is currently in deflation (but expected to revert to positive inflation in the projections), the size of the shock is smaller compared to the other countries. Moreover, being temporary, the negative inflation shock implies a much faster recovery of the GDP deflator in positive territory over the long term.

Table 7

Impact of Adverse Inflation Shocks on the Debt-to-GDP Ratio in 2024 and on the Average Budget Balance Over 2014-24
(percent of GDP, deviation from baseline)

	Low Inflation Shock				Country-Specific Negative Inflation Shock*	
	Permanent Shock		Temporary Shock			
	Debt Effect (2024)	Average Impact on Budget Balance (2014-24)	Debt Effect (2024)	Average Impact on Budget Balance (2014-24)	Debt Effect (2024)	Average Impact on Budget balance (2014-24)
Austria	8.1%	–0.2% [0.0]	5.7%	–0.3%	11.3%	–0.3%
Germany	6.6%	–0.1% [–0.1]	4.9%	–0.2%	11.4%	–0.2%
France	8.7%	–0.1% [–0.2]	5.8%	–0.2%	13.4%	–0.4%
Greece	18.6%	–0.5% [0.3]	11.8%	–0.6%	15.5%	–0.3%
Italy	11.5%	–0.1% [–0.1]	7.9%	–0.3%	23.2%	–0.9%
Average	**10.7%**	**–0.2%** [0.0]	**7.2%**	**–0.3%**	**15.0%**	**–0.4%**

Sources: authors' elaboration.
* The size of the shock is country specific and as a result, the resulting effects on the debt stock are not directly comparable across countries. For the permanent shock scenario, the value in square brackets illustrates the average deviation of effective interest rates compared to the baseline.

6 Policy implications

The adverse impact of unfavourable inflation developments on public finances raises the issue of whether this may hinder compliance with the requirements under the SGP. To briefly recap, the main indicators for the assessment of compliance with the SGP (both under its preventive and the corrective arm) are the *nominal budget balance* and the *structural budget balance.* Under the corrective arm, the so-called *effective action* procedure foresees that if a country fails to comply with either the nominal balance or the structural effort targets, a *careful analysis* is undertaken. The careful analysis relies on the *adjusted structural balance* (*i.e.,* corrected for revenue windfalls and changes in potential growth) and the so-called (bottom-up) *fiscal effort*. The latter sums up the budgetary impact of individual measures on the revenue side; on the expenditure side it assesses measures as improvements compared to the nominal expenditure path as included in the EDP recommendation. Finally, the six-pack reform has operationalised the debt rule.[21] For the countries that in November 2011 were under an EDP, a three-year transition period has been introduced. During the transition period a country needs to make sufficient progress with its structural adjustment to ensure that it complies with the debt rule after the end of the transition period. Sufficient progress is measured with reference to the minimum linear structural adjustment (MLSA) which is the least stringent adjustment in the structural balance required for compliance with one of the three specifications of the debt rule (backward looking, forward looking and adjusted for the cycle).

[21] This rule requires countries whose debt-to-GDP ratio is in excess of 60 per cent, to reduce it by 1/20 of the excess over 60 per cent in each year.

Inflation may then affect the assessment of countries' compliance with the SGP requirements as it affects the nominal and the structural budget balances, their change and the fiscal effort. As shown in this note, a 1p.p. unanticipated decline in the rate of inflation (or GDP deflator) would translate into a deterioration of the budget balance ranging from about 0.04p.p. of GDP on impact in the case of France and Greece to 0.11p.p. of GDP for Italy and Austria. Depending on the country specific circumstances, the effect can become stronger over time (e.g., France) or fade progressively away (e.g., Austria) or be very limited altogether (e.g., Germany). Therefore, a deceleration in the growth rate of inflation could cause both the nominal balance and the structural balance[22] to deteriorate to different degrees across countries.

As regards the impact of inflation on the size of the (bottom-up) fiscal effort, the implications of lower than expected inflation crucially depend on the behaviour of expenditures. If spending adjusts downwards in line with inflation developments, than lower inflation leads to an increase of the expenditure savings *vis-à-vis* the benchmark of the nominal expenditure path included in the EDP recommendation. Inflation effects on the spending side therefore could make compliance with the fiscal effort recommendation under the EDP easier. However, in case spending does not adjust, as seen in section 4, then compliance with the fiscal effort would be hindered.

The implications of lower inflation are more significant in the case of the debt rule. The size of the MLSA, which is defined in terms of a requested improvement of the structural balance, is affected, among other factors, by the gap between the debt-to-GDP ratio and the 60 per cent reference value. As shown in section 4.2, for a very high debt-to-GDP ratio a 1p.p. lower inflation leads to an almost equivalent increase in the debt ratio. Moreover, the DSA has shown that a persistent shock to inflation determines an increase in the debt ratio of up to 19p.p. in the case of Greece, thus jeopardizing debt sustainability. Therefore, unexpectedly lower inflation has negative effects on countries' capacity to comply with the debt rule via both the negative impact on the debt ratio (*i.e.,* leading to a widening of the gap vs. the 60 per cent) and via a lowering of the realised structural adjustment vis-à-vis the requirement under the MLSA. Finally, as we have seen, the implications for compliance with the SGP rules tend to be more severe in the case of a negative inflation shock. Nonetheless, and as stressed various times in this note, to the extent that lower inflation translates into lower interest payments via lower inflation expectations, the resulting savings in interest payments, although initially limited, would partially offset the negative impact of inflation on budget balance. This partially counterbalancing effect would not, however, materialize in the current circumstances, given that the euro area economy is at the zero lower bound.

The SGP does not include specific reference to adverse inflation developments among the circumstances under which derogation to the rules can be granted. Under the recently amended method to assess effective action under the corrective arm of the Pact, it was conjectured that the impact of inflation may be considered in the careful analysis in cases in which the change in the adjusted structural effort and the bottom-up fiscal effort point in different directions. This has so far not been applied. At the same time, under the corrective arm of the Pact, a so-called general escape clause exists, which refers to periods of a severe economic downturn for the euro area or the Union as a whole. It provides for revisions in EDP recommendations if this does not endanger fiscal sustainability. While there is no specific definition in the SGP of a severe economic downturn, in case tail risks of negative growth and deflation materialise, an application of such a clause might need to be considered. The case for doing so would be stronger if deflation affects core components of HICP and GDP deflator as risks for the economy and public finances are more severe. However,

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[22] We assume that a deterioration in the headline balance, which is due to lower inflation, is entirely of a structural nature as the cyclical component, which is based on the output gap, is not affected.

it needs to be recalled that if deflation materialises in the absence of a severe economic downturn (*i.e.,* in the presence of positive or mildly negative real output growth and output gap), then the general escape clause will likely not apply.

In the context of the debt rule there is no specific provision for low or negative inflation developments as a factor justifying lack of compliance with the rule. In particular, in case a significant deviation from the MLSA is diagnosed, which triggers the preparation of a report under Art.126(3) TFEU, the Commission in deciding whether an excessive deficit exists in the sense of the debt rule shall take into account all relevant factors as indicated in article 2(3/4) of regulation 1467/2011. Such factors include consideration of: i) developments in the medium-term economic position[23] ii) the developments in the medium-term budgetary positions;[24] iii) the developments in the medium-term government debt position.[25] Moreover, the Commission shall give due and express consideration to any other factors which, in the opinion of the Member State concerned, are relevant in order to comprehensively assess compliance with deficit and debt criteria and which the Member State has put forward to the Council and the Commission. Although also in the case of the debt rule adverse inflation developments are not explicitly mentioned as a factor justifying a deviation from the rules, a country can still ask the Commission to consider adverse inflation developments among the other factors relevant for the assessment of compliance with the debt rule.[26]

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[23] This includes potential growth, including the various contributions provided by labour, capital accumulation and total factor productivity, cyclical developments, and the private sector net savings position.

[24] This includes, in particular, the record of adjustment towards the medium-term budgetary objective, the level of the primary balance and developments in primary expenditure, both current and capital, the implementation of policies in the context of the prevention and correction of excessive macroeconomic imbalances, the implementation of policies in the context of the common growth strategy of the Union, and the overall quality of public finances, in particular the effectiveness of national budgetary frameworks.

[25] This includes debt dynamics and sustainability, including, in particular, risk factors including the maturity structure and currency denomination of the debt, stock-flow adjustment and its composition, accumulated reserves and other financial assets, guarantees, in particular those linked to the financial sector, and any implicit liabilities related to ageing and private debt, to the extent that it may represent a contingent implicit liability for the government.

[26] However, internal ECB analysis for the case of Italy shows that even taking into account currently low inflation as a relevant factor, compliance with the MLSA would not be ensured and the size of deviation from the required adjustment would remain significant in the sense of the debt rule in both 2014 and 2015 in the absence of additional measures.

ANNEX 1
THE CALCULATION OF THE FISCAL DRAG

The following calculations concerning the nominal effects of fiscal drag are based on the private consumption deflator. In the case of income tax revenue, the price effect of fiscal drag can be calculated as follows:

$$FD(\pi) = T_{wt_{t-1}} * (\varepsilon_{wt_t} - 1) * \left(\frac{Def_t}{Def_{t-1}} - 1\right)$$

where $T_{wt_{t-1}}$ is the tax revenue from wage tax (excluding minor occupations) in t–1. While ε_{wt_t} is the elasticity of wage tax with respect to changes in per capita wages and salaries, *Def* is the price deflator for private consumption in t and t–1, respectively.

The nominal effect of fiscal drag can also be calculated for excise taxes. However, unlike income tax, excise taxes are computed on a quantitative basis. When calculating the nominal effect of fiscal drag on excise taxes, we assume that the assessment base for gauging the inflation effect is linked to real private consumption and not to nominal private consumption. It is also assumed that the elasticity of tax revenue from excise taxes in terms of changes to real private consumption is smaller than 1. This being the case, the nominal part of fiscal drag on excise taxes is calculated as follows

$$FD(\pi) = T_{ET_{t-1}} * \begin{pmatrix} PV_{real_t} & PV_{nominal_t} \\ PV_{real_{t-1}} & PV_{nominal_{t-1}} \end{pmatrix}$$

where $T_{ET_{t-1}}$ is tax revenue from excise taxes in the last period, PV_{real_t} denotes real private consumption (data taken from the national accounts) and $PV_{nominal_t}$ refers to nominal private consumption.

ANNEX 2
EFFECTS OF INFLATION ON THE STOCK OF DEBT

To better understand the effect of inflation on the stock of outstanding debt and the interest payments to GDP, equation (2) reformulates the standard debt accumulation equation by expressing the total debt-to- GDP ratio as the sum of b_t^S the portion of debt that is sensitive to inflation (*i.e.,* short-term debt, foreign-currency denominated debt, long-term variable-interest or inflation-indexed debt) and b_t^{NS} the portion which includes only domestic-currency denominated, long-term, non-indexed debt:[27]

$$b_t^{TOT} = b_t^S + b_t^{NS} = \frac{1+i}{1+g} b_{t-1}^S + \frac{1+i^*}{1+g} b_{t-1}^{NS} - pb_t \quad (1)$$

i is the interest rate on b_t^S, i^* is the interest rate on b_t^{NS}; g is the growth rate of nominal GDP and pb_t is the primary balance.[28] Equation (2) can be further rearranged and expressed as: The right hand-side of equation (1) can be further rearranged as the sum of debt outstanding from the previous period ($\frac{1}{1+g} d_{t-1}$ | $\frac{1}{1+g} d_{t-1}^*$) and the interest payments due on such debt:

$$\frac{i}{1+g} d_{t-1} + \frac{i^*}{1+g} d_{t-1}^*,$$

Furthermore, if we define r and r^* as the market real interest rate on d_t and d^*_t respectively, n as the real growth rate of GDP, π_t and π_t^{exp} as the realised and expected inflation for period t, and noting that $(1+i)=(1+r)(1+\pi_t)$, $(1+i^*)=(1+r^*)(1+\pi_t^{exp})$ and $(1+g)=(1+n)(1+\pi_t)$, equation (1) can be written as:

$$d_t^{tot} = \frac{1+r}{1+n} d_{t-1} + \frac{(1+r^*)(1+\pi_t^{exp})}{(1+n)(1+\pi_t)} d_{t-1}^* - a_t \quad (2)$$

The first term on the right hand side of equation (2) captures the contribution to the debt-to-GDP dynamics of the component of debt whose cost is inflation-sensitive. This term does not depend on inflation. It is the sum of two parts: debt outstanding from the previous period ($\frac{1}{(1+n)(1+\pi)} d_{t-1}$), which depends negatively on inflation, and interest payments ($\frac{i}{(1+n)(1+\pi)} d_{t-1} = \frac{(1+r)(1+\pi)-1}{(1+n)(1+\pi)} d_{t-1}$), which depend positively on inflation, with the two opposing effects cancelling out.

The second term in equation (2), depends negatively on actual inflation. Indeed, its "debt outstanding" part is given by $\frac{1}{(1+n)(1+\pi)} d_{t-1}^*$ and its interest payment part is given by: $\frac{(1+r^*)(1+\pi_t^{exp})-1}{(1+n)(1+\pi)} d_{t-1}^*$, both being unambiguously decreasing with respect to π. This effect is quantitatively small, given that the ratio of interest payments to GDP is typically much less than one. However, it is worth noting that to the extent that higher (lower) inflation leads to a change in

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[27] A more detailed version of this equation is discussed in Akitoby et al. (2013).

[28] For ease of exposition, we did not take into account that the various components of d* might have different interest rates, and we disregard time sub-indices. The equation also assumes a full Fisher effect. This will be relaxed below.

Table 8

The Structure of Debt

Debt structure	Germany	France	Italy	Austria (1)	Greece
	(in % of total debt)				
1. Debt denominated in euros	97%	97%	100%	100%	96%
2. Debt denominated in other currencies	3%	3%	0%	0%	4%
3. Debt with residual maturity up to 1 year	25%	22%	25%	10%	10%
4. Debt with residual maturity over 1 year	75%	78%	75%	90%	90%
5. Of which: variable interest rate	*6%*	*0%*	*7%*	*1%*	*67%*
6. Share of debt sensitive to unexpected changes in inflation (d^*/d_{tot}) **(4-5-2)/7**	*66%*	*75%*	*68%*	*88%*	*19%*
7. Share of debt not sensitive to unexpected changes in inflation (d/d_{tot}) **(8-6)/8**	*34%*	*25%*	*32%*	*12%*	*81%*
Memorandum items	EUR bn, years				
8. Gross consolidated debt	2,147,028	1,925,300	2,069,216	227,173	318,703
9. Nominal GDP	2,737,600	2,059,852	1,560,024	307,003	182,054
10. Average residual maturity of debt	6.1	7.0	6.9	8.1	16.0

(1) 2012 data.

inflation expectations, hence a higher nominal interest rate required by the market, the second term in equation (2) does not depend on inflation either (to the extent that the real interest rate remains constant and that a full Fisher effect is at work).

Overall, the elasticity of the debt-to-GDP-ratio to the inflation rate is a function of $\frac{d_t^*}{d_t^{tot}}$, the share of **the long-run, domestic-currency-denominated, fixed-rate part of the debt.** In particular, when the pass through from low inflation to the nominal interest rate is one-to-one the formula for the elasticity is:

$$\varepsilon_{d_t^{tot},\pi} = -\left(\frac{\pi}{1+\pi}\right)\left(\frac{d_t^*}{d_t^{tot}}\right). \tag{3}$$

On the other hand, when the pass-through is less than one, the elasticity is:

$$\varepsilon_{d_t^{tot},\pi} = -(1-k)\left(\frac{\pi}{1+\pi}\right)\left(\frac{d_t}{d_t^{tot}}\right) - \left(\frac{\pi}{1+\pi}\right)\left(\frac{d_t^*}{d_t^{tot}}\right). \tag{3'}$$

In this case we assume that in equation (1) $(1+i)=(1+r)(1+k\pi_t)$, where $k\leq 1$ ($k=1$ in the full Fisher effect).

Equation (3') differs from equation (3) for the term: $-(1-k)\left(\frac{\pi}{1+\pi}\right)\left(\frac{d_t}{d_t^{tot}}\right)$. The intuition behind this term is straightforward. With $k=1$ inflation reduces the debt-to-GDP ratio only via d^*. With $k<1$ also d contributes, because the outstanding-debt effect on d is only partially counterbalanced by the increased interest payments effect. This happens because also the real interest rate r due on d is reduced by inflation, as now the nominal interest rate (i) reacts less than 1-to-1 to π.

Finally, as regards the sensitivity of interest payments to inflation, it is worth noting that **total interest payments may or may not increase with inflation**. Indeed, they are given by:

$$(Int.paym./GDP)_t \approx \frac{r+\pi}{1+n+\pi} d_{t-1} + \frac{r^*+\pi_t^{exp}}{1+n+\pi} d^*_{t-1}$$

so that:

$$\frac{\partial inp}{\partial \pi} \approx \frac{1}{(1+n+\pi)^2}\left[(1+n-r)\frac{d_{t-1}}{d^{tot}_{t-1}} - (r^* + \pi^{\exp})\frac{d^*_{t-1}}{d^{tot}_{t-1}}\right] d^{tot}_{t-1} \quad ,$$

where the term in square brackets is of ambiguous sign.

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